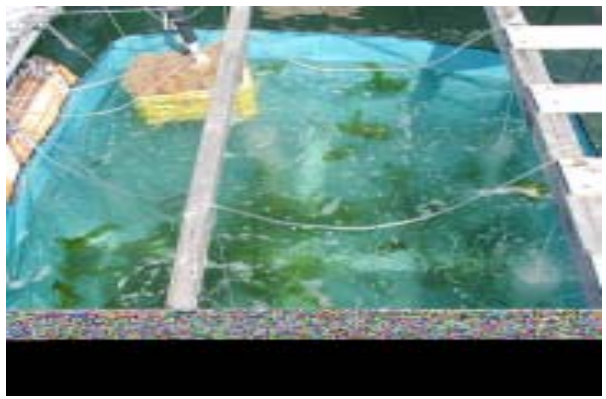
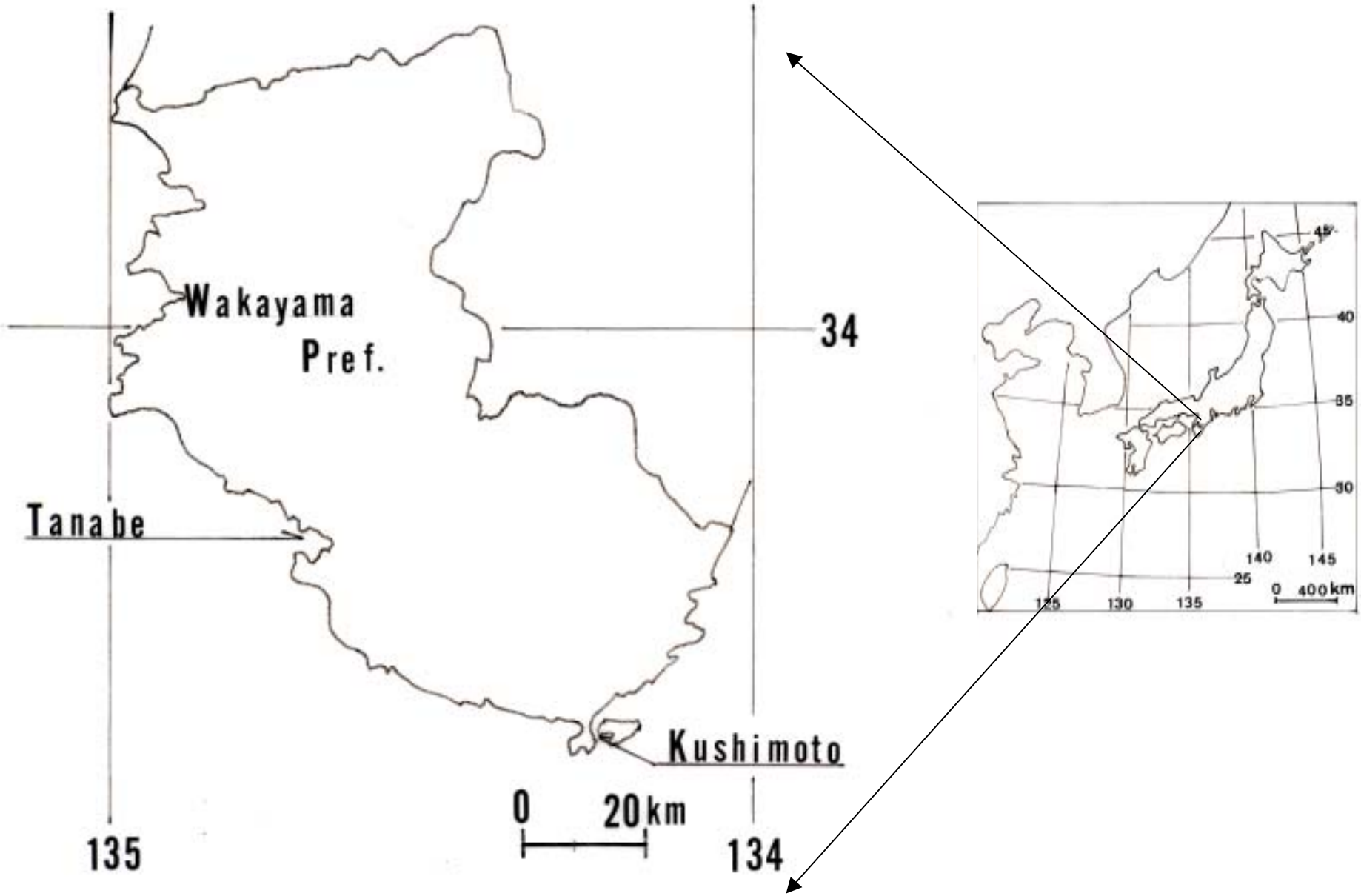
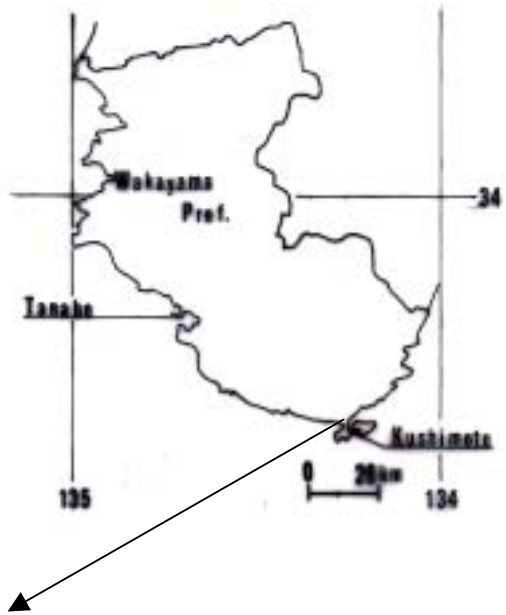
Ulva species and *Undaria undarioides* culture for reducing nitrogen and phosphorus from fish culture areas in Wakayama Prefecture, Japan

Hajime Kimura and Masahiro Notoya

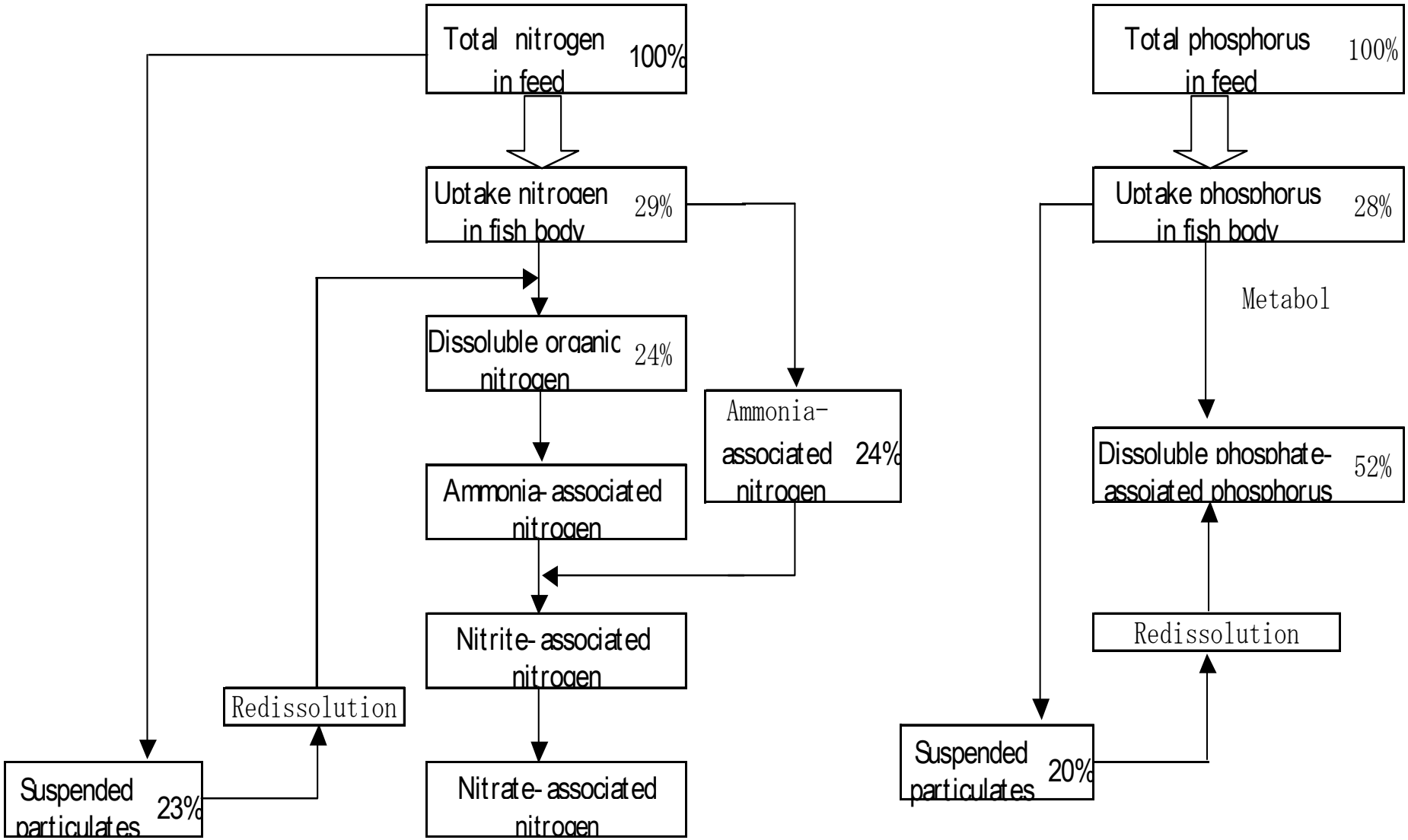




Map showing fish culture areas at Tanabe and Kushimoto cities in Wakayama Prefecture, Japan.

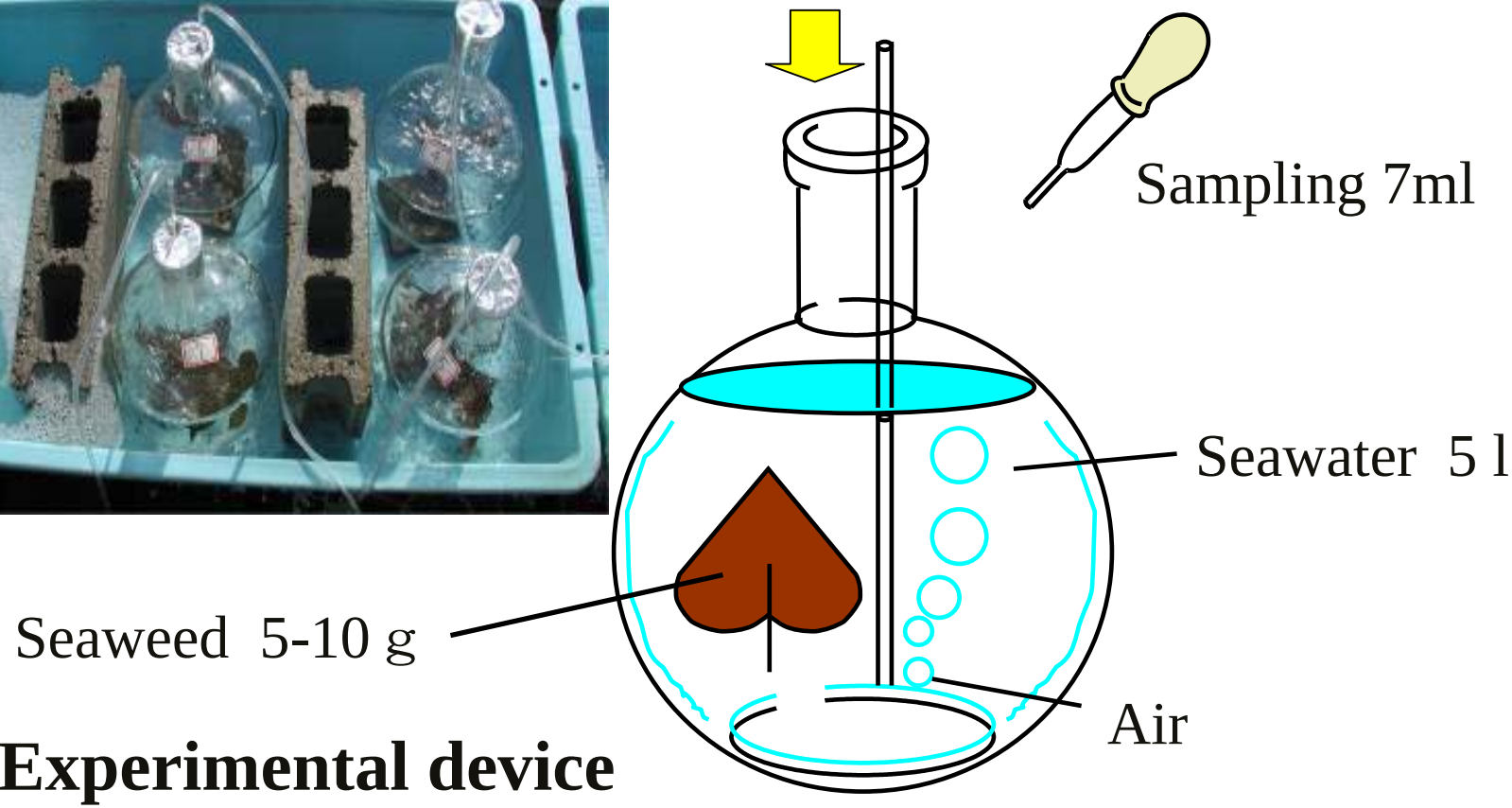


Fish culture area on the coast of Kushimoto city at the southernmost of Wakayama Prefecture, Japan.



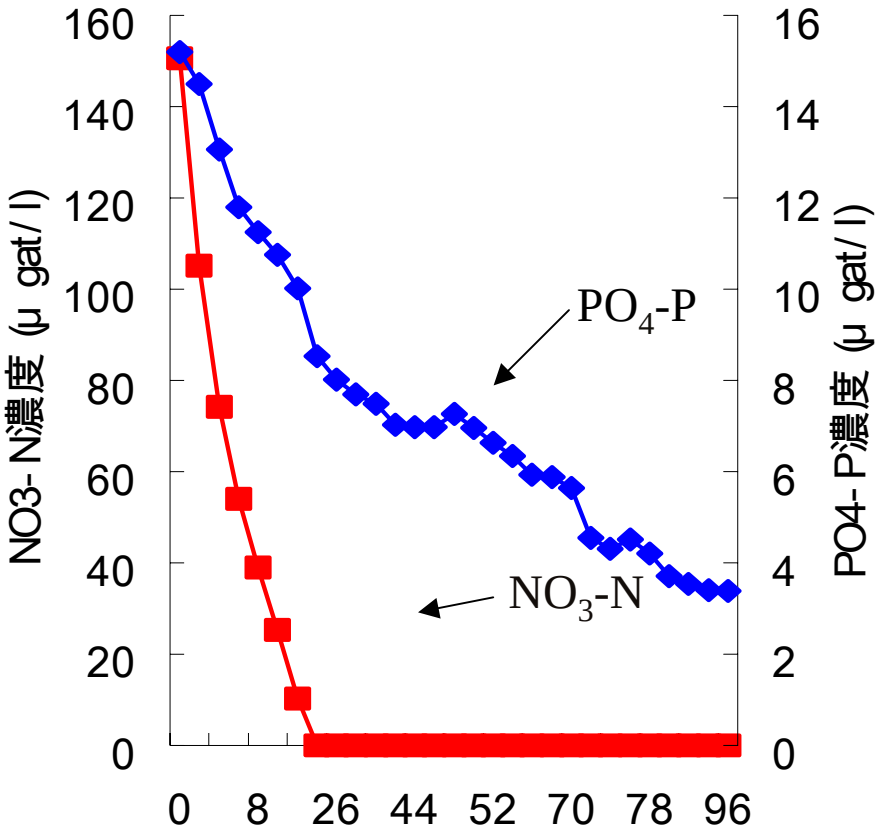
Influx and efflux of nitrogen and phosphorus at the red sea bream culture system.

Component of culture medium of N and P		
Nitrogen	($NaNO_3$)	150 μ g at / l
Phosphorus	(K_2HPO_4)	15 μ g at / l



Experimental device

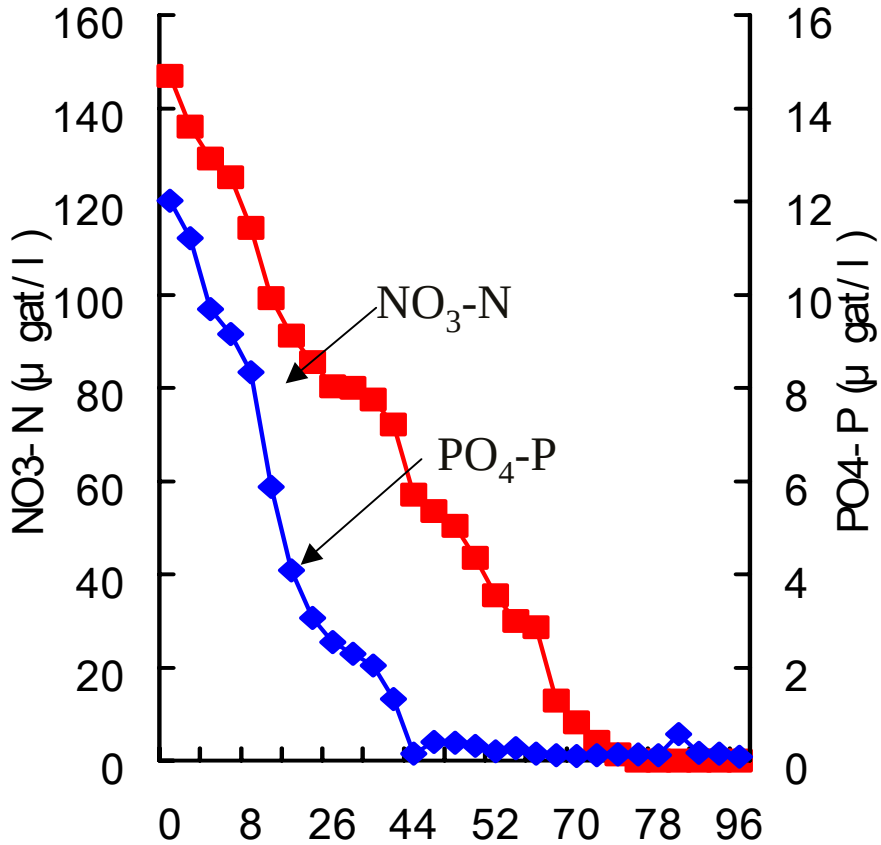
Ulva sp.



Nitrogen 3.42mg /wet g/day

Phosphorus 0.18mg/wet g/day

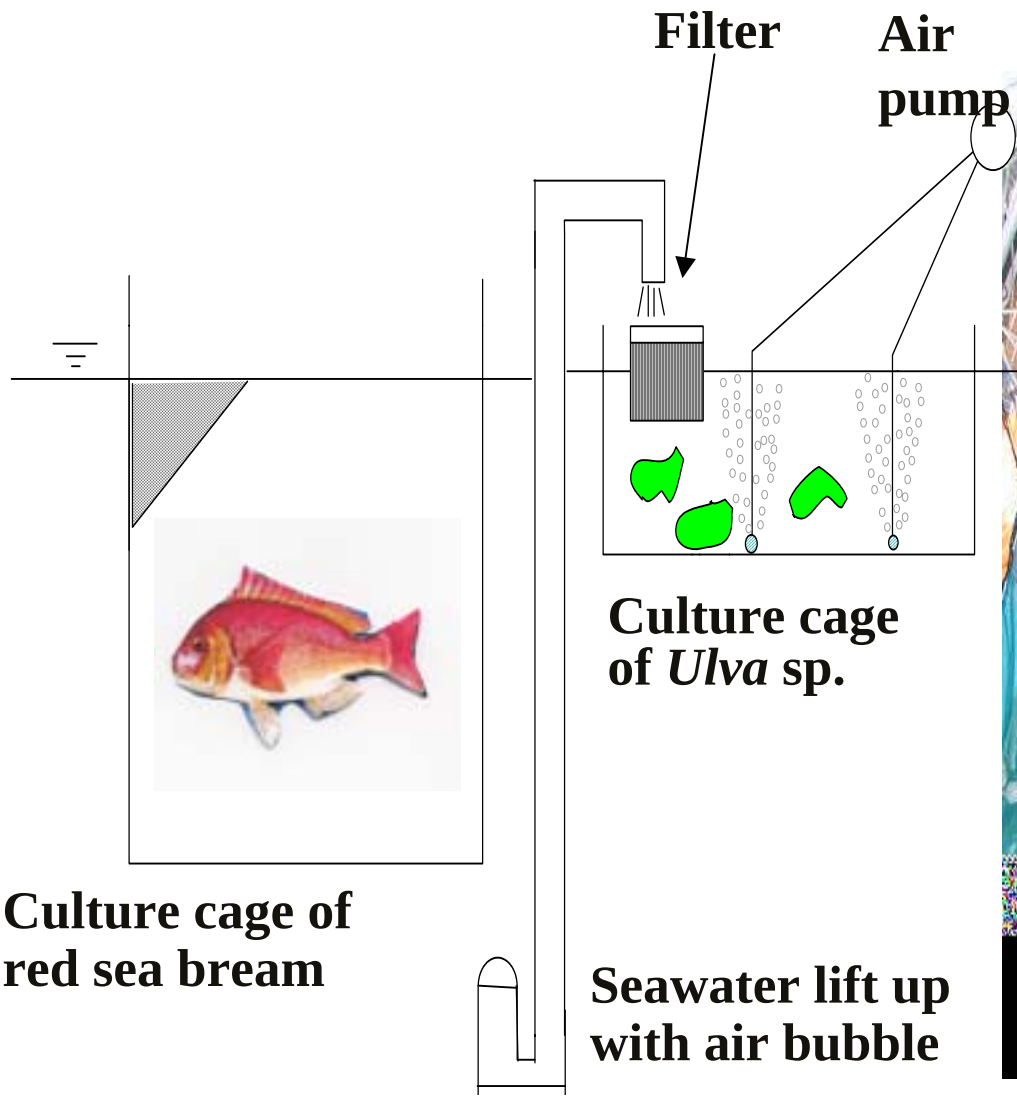
U. undarioides

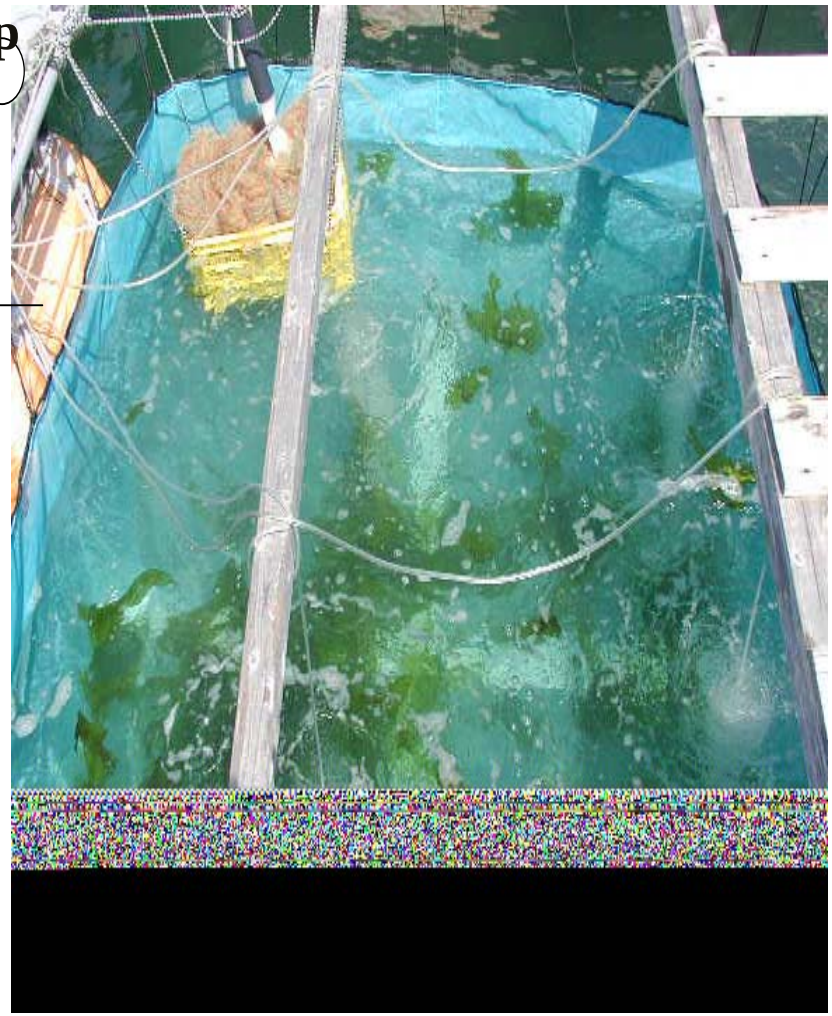


Nitrogen 0.81mg /wet g/day

Phosphorus 0.25mg /wet g/day

Uptake rate of nitrogen and phosphorus in flask culture





Cage culture system of red sea bream and *Ulva* sp.

Maine component of *Ulva* sp.

Moisture	g/ 100g	79.6
Crude fat	g/ 100g	0.5
Total nitrogen	g/ 100g	0.7
Total phosphorus	mg/ 100g	45

3, 200－1, 000＝2, 200 g (Growth of *Ulva* sp. for 6 days)

2, 200 g×0. 007=15. 4 g (Nitrogen uptake over 6 days)

15, 400 mg÷6 day÷1, 000 g=2. 56 mg/g wet weight/day

2, 200 g×0. 00045=990 mg (Phosphorus uptake over 6 days)

990 mg÷6 days÷1, 000 g＝0.17 mg/g wet weight/day

Results of cage culture of red sea bream fed with EP-pellets in a 3×3×3m from Sep.9 to Dec13.

No. of fish	Average body fish(g) Initial	Final	Amount of diets(g)	Weight gain(g)
225	74.1	172.7	37,300 A	19,600 B

Component of diets and fish body of red sea bream.

		Diet		Fish body	
Moisture	(%)	2.1		67.3	
Crude protein	(%)	49.0	C	17.7	D
Crude fat	(%)	20.4		9.6	
Crude ash	(%)	9.2		4.7	
Phosphorus	(%)	1.540	E	0.860	E

Phosphorus in diets

A×E/100＝574 g

Nitrogen in diets

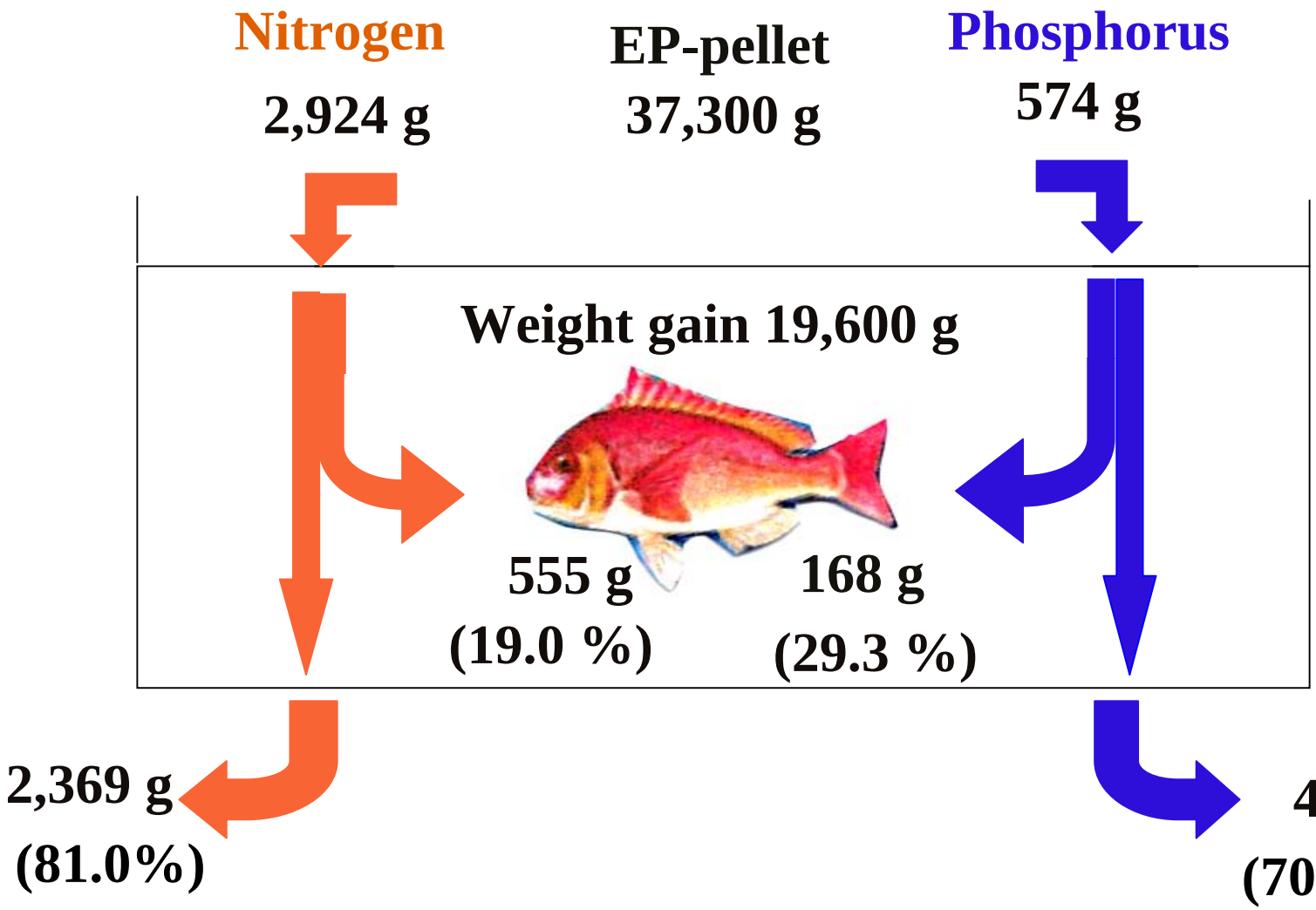
A×C/100×0.16= 2,924 g

Nitrogen in the fish body of red sea bream

B×D/100×0.16=555 g

Phosphorus in the fish body of red sea bream

B×F/100=169 g



Influx and efflux of nitrogen and phosphorus in red sea bream culture from Sep.9 to Dec. 13

Production of *Ulva* sp. during the culture period with red sea bream

2,200 g×16 weeks=35,200 g

Uptake nitrogen by *Ulva* sp.

35,200 g×0.007=246.4 g

Uptake phosphorus by *Ulva* sp.

35,200 g×0.00045 = 15.8 g

Load of nitrogen from the red sea bream: 2,369 g

Load of phosphorus from the red sea bream: 406 g

Removable nitrogen by *Ulva* sp. which loaded from the red sea bream. 246.4 g ÷ 2,369 g = 0.104 (10.4 %)

Removable phosphorus by *Ulva* sp. which loaded from the red sea bream. 15.8 g÷406 g = 0.039 (3.9 %)

Undaria undarioides.

Main component of *Undaria undarioides*

Moisture	g/ 100g	90.3
Crude fat	g/ 100g	0.1
Total nitrogen	g/ 100g	0.3
Total phosphorus	mg/ 100g	34

27.4 g（Growth of *U. undarioides* for 86 days）

27.4 g × 0.003 = 82.2 mg（nitrogen uptake for 86 days）

82.2 mg ÷ 86 days = 0.96 mg/g wet weight/day

27.4 g × 0.00034 = 9.3 mg (phosphorus uptake for 86 days)

9.3 mg ÷ 86 days= 0.11 mg/g wet weight/day

Results of cage culture of red sea bream fed with EP-pellets in a 3×3×3m from 14 Dec. to 12 Mar.

No. of fish	Fish body weight (g)		Amount of diets(g)		Weight gain(g)	
	Initial	Final				
260	172.7	205.3	18,300	A	8,297	B

Compositions of diet and body mass of red sea bream

		Diet		Body	
Moisture	%	2.1		67.3	
Crude protein	%	49.0	C	18.3	D
Crude fat	%	20.4		9.6	
Crude ash	%	9.2		4.7	
Phosphorus	%	1.54	E	0.85	F

Nitrogen in diet

A×C/100×0.16=1,435 g

Nitrogen in the fish body of red sea bream

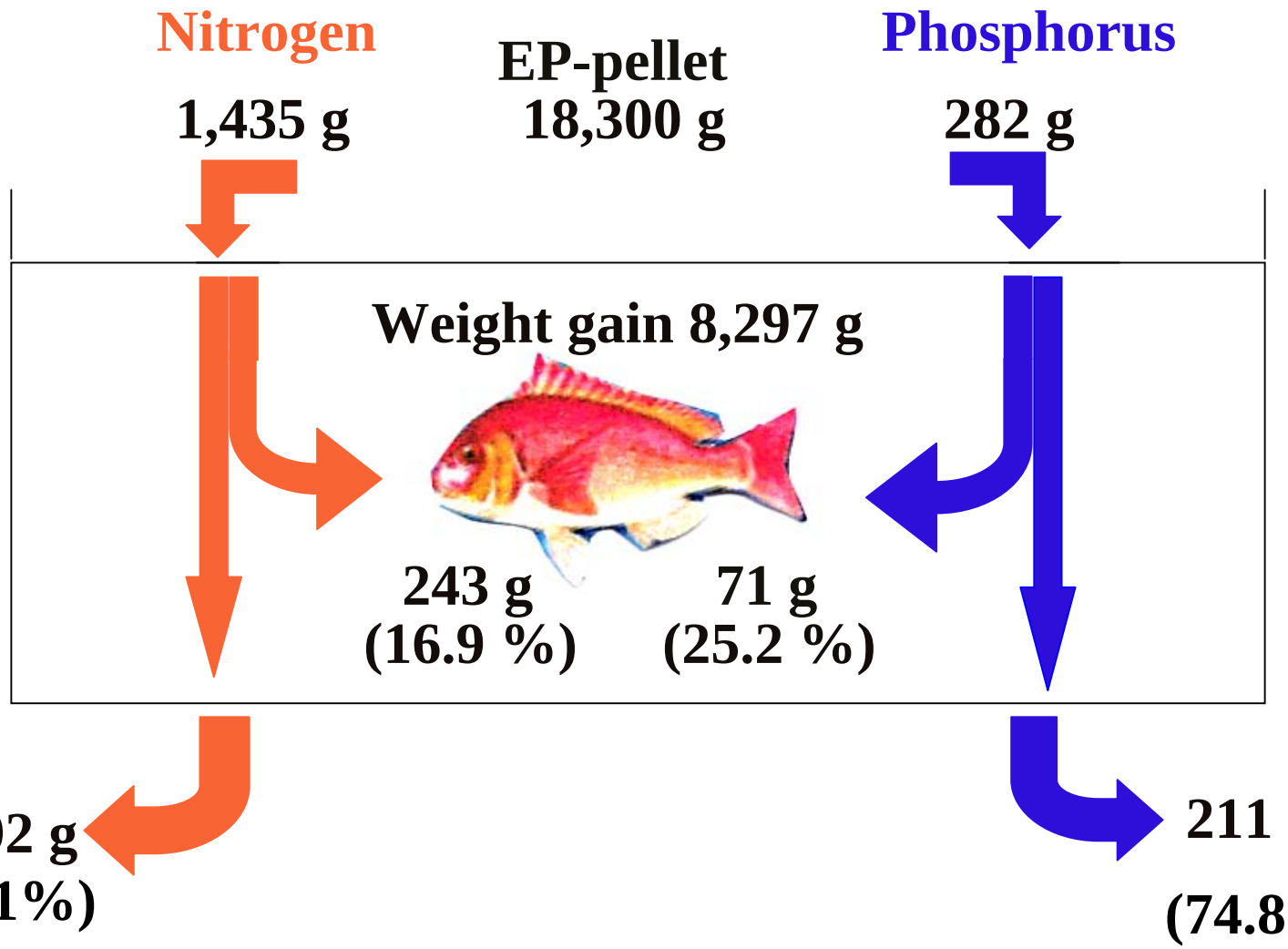
B×D/100×0.16=243 g

Phosphorus in diet

A×E/100 = 282 g

Phosphorus in the fish body of red sea bream

B×F/100 ＝ 71 g



Influx and efflux of nitrogen and phosphorus in red sea bream culture during low water temperature.

Production of *U. undarioides* from Nov. 28 to Mar. 14
161 kg

Uptake nitrogen by *U. undarioides*

161 kg × 0.003 = 483 g

Uptake phosphorus by *U. undarioides*

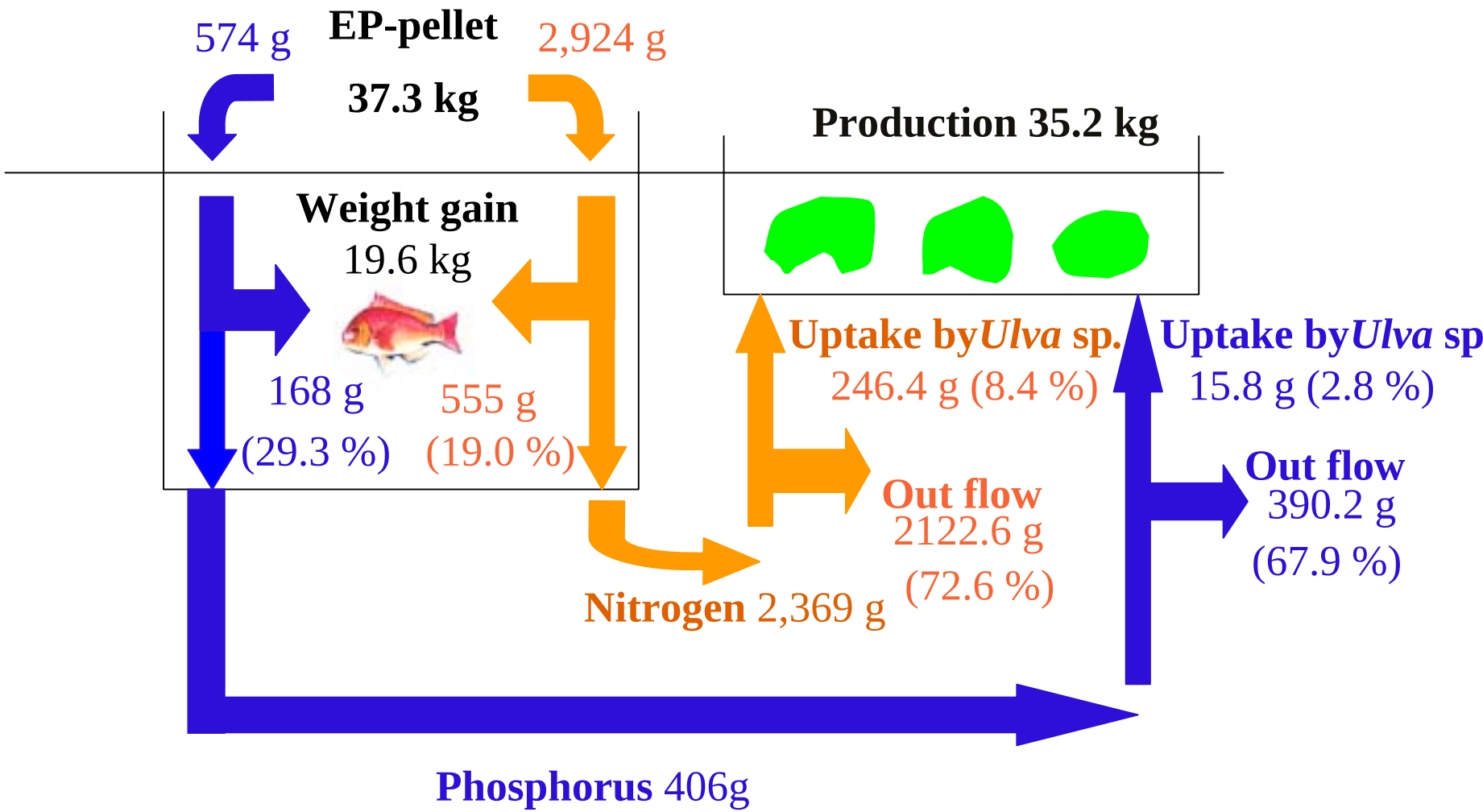
161 kg × 0.00034 = 54.7 g

Removable nitrogen by *U. undarioides* which loaded from the red sea bream culture

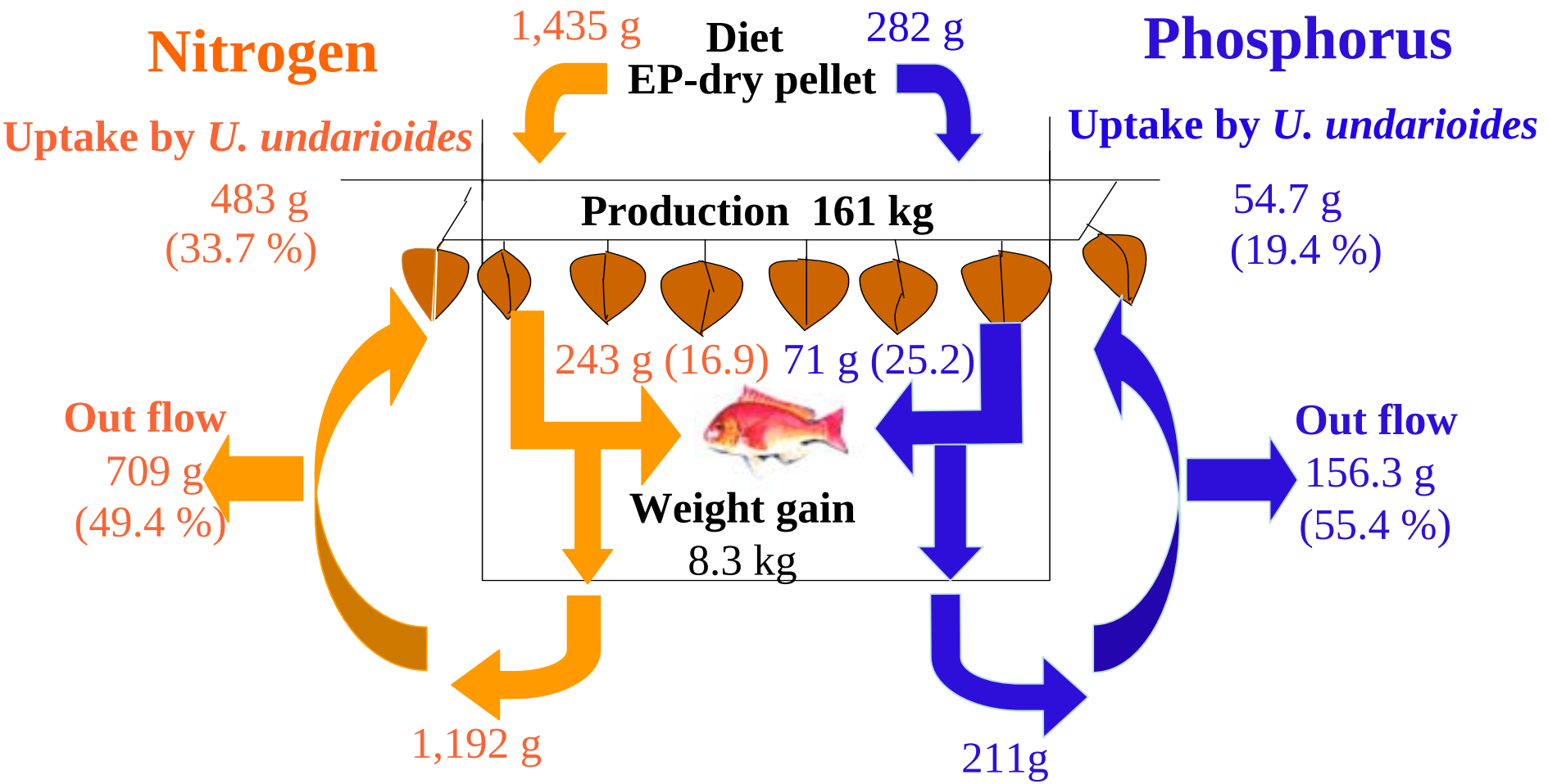
483 g ÷ 1192 g =40.5 %

Removable phosphorus by *U. undarioides* which loaded from the red sea bream culture

54.7 g ÷211 g =25.9 %

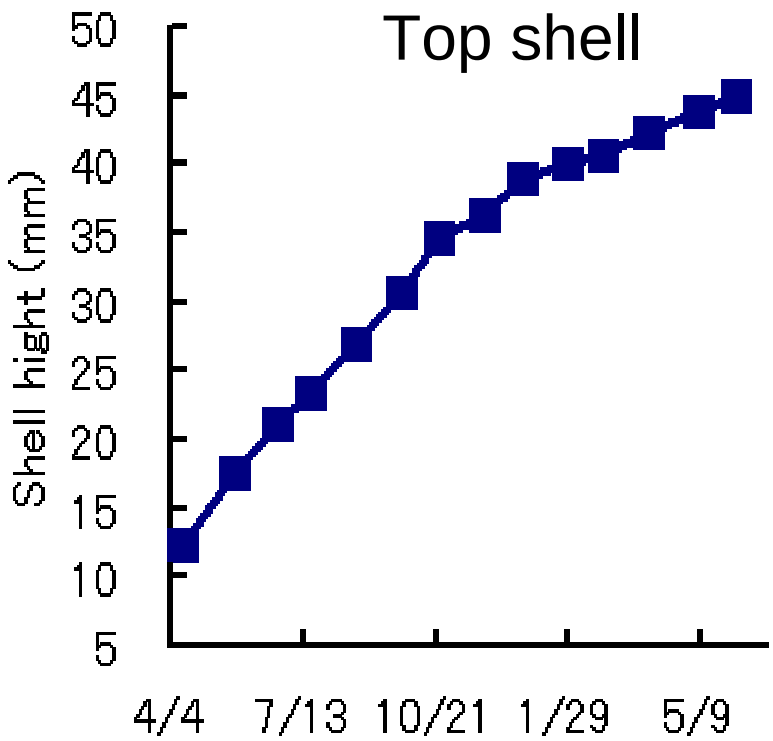


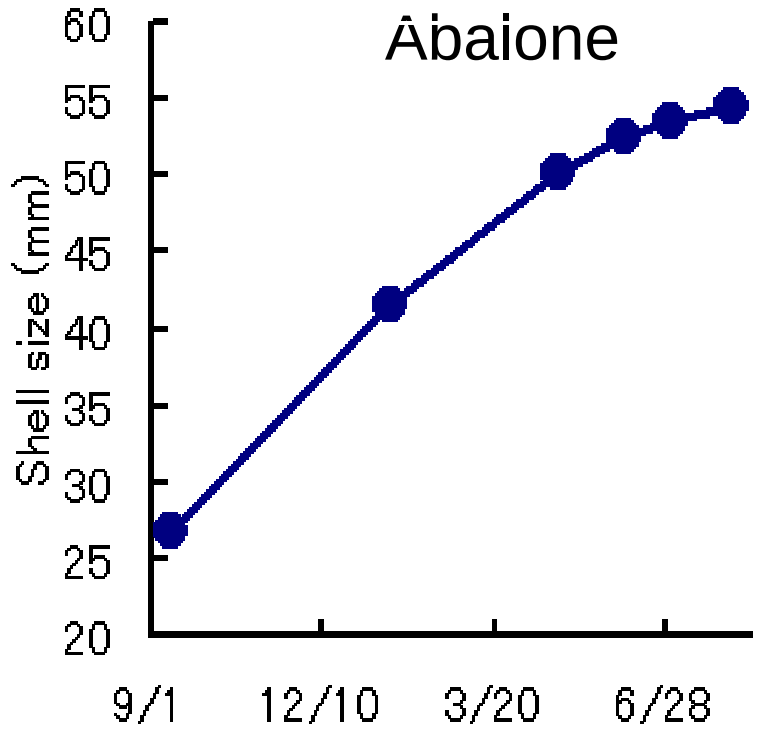
Circulation of nitrogen and phosphorus at the red sea bream with *Ulva* sp. culture.



Circulation of nitrogen and phosphorus at the red sea bream with *U. undarioides* culture.

Culturing of top shell (*Batillus cornutus)* and abalone (*Notohaliotis siebolidi*)





Growth of the top shell and the abalone in sea surface cultivation.

Thank you for your attention.

H. Kimura and M. Notoya